Report of the Kew Committee for the Year ending October 31, 1889.

The operations of The Kew Observatory, in the Old Deer Park, Richmond, Surrey, are controlled by the Kew Committee, which is constituted as follows:

Mr. F. Galton, *Chairman.*

Captain W. de W. Abney, C.B., R.E.	The Earl of Rosse.
Prof. W. G. Adams.	Prof. A. W. Rücker.
Staff-Commander E. W. Creak, R.N.	Mr. R. H. Scott.
Prof. G. C. Foster.	Lieutenant-General R. Strachey, C.S.I.
Admiral Sir G. H. Richards, K.C.B.	General J. T. Walker, C.B.
	Captain W. J. L. Wharton, R.N.

The work at the Observatory may be considered under the following heads:—

1st. Magnetic observations.
2nd. Meteorological observations.
3rd. Solar observations.
4th. Experimental, in connexion with any of the above departments.
5th. Verification of instruments.
6th. Rating of Watches and Marine Chronometers.
7th. Miscellaneous.

The Royal Society's Committee of the Kew Observatory, since the issue of the last Report, have lost by the death of Mr. de la Rue a colleague who for nearly forty years had taken a prominent part in the management of the Observatory, and who had long presided over the Committee as their Chairman. Mr. de la Rue was one of the most munificent benefactors of the Observatory. It was at his suggestion that the first photoheliograph was constructed and brought into use under his supervision at the Observatory. His sound practical judgment and thorough familiarity with scientific operations of all kinds were of constant service to the Committee, and his loss will be greatly felt by them.

I. Magnetic Observations.

No change has been made in the magnetographs during the past year. The curves representing Declination, Horizontal Force, and Vertical Force variations have been obtained uninterruptedly, and, as in former years, the scale values of all the instruments were determined in the month of January.

The ordinates of the various photographic curves were then ascertained to be as follows :—

Declination : 1 inch = 0° 22′·04. 1 cm. = 0° 8′·7.

Bifilar, January 15, 1889, for 1 inch δH = 0·0278 foot grain unit.
„ 1 cm. „ = 0·00050 C.G.S. unit.
Balance, January 16, 1889 „ 1 inch δV = 0·0285 foot grain unit.
„ 1 cm. „ = 0·00052 C.G.S. unit.

The principal magnetic disturbance of the year was recorded on the morning of July 16th; on July 11th between 10 and 11 P.M. the curves registered the passage of tremors from an earthquake which was experienced in Central Asia.

Observations with the absolute instruments have been made monthly, and the results are given in the tables forming Appendix I of this Report.

The magnetic instruments have been studied, and a knowledge of their manipulation obtained, by Lieutenant W. J. Combe, R.N., of H.M.S. "Penguin."

With a view of ensuring accuracy in the tables employed in the reduction of magnetic observations, which have been frequently reprinted for use by observers, a careful examination has been made by Professor G. Carey Foster of all the formulæ and blank forms employed in the Kew methods. He has reported to the Committee that he did not detect any inaccuracy.

A careful examination of the observations of Absolute Declination made at Kew from 1858 to the present date has been made at the request of Professors Thorpe and Rücker, who have been investigating the secular changes of Declination during the interval. The results have been forwarded to those gentlemen with the object of their embodiment in the paper on the Magnetic Survey of the British Islands now in progress submitted by them to the Royal Society.

In order to examine certain features of the working of the Kew pattern Vertical Force magnetograph instrument, Mr. Charles Chambers, F.R.S., Director of the Colába Observatory, Bombay, has been provided by the Indian Government with a new instrument of the same pattern, which has been tested at Kew, and forwarded by the maker, Adie, to Bombay.

Dr. van Rijckevorsel, of Rotterdam, visited the Observatory to redetermine the constants of his instruments, and make observations of the magnetic elements prior to the commencement of a new magnetic survey of Holland and Belgium, which he has undertaken under the auspices of the Koninklijke Akademie van Wetenschappen te Amsterdam, so as to connect M. Moureaux's survey of France with Dr. Neumayer's survey of Germany. Dr. van Rijckevorsel selected Kew, Wilhelmshaven, and Paris as his base stations.

Mr. Kitto, Superintendent of the Falmouth Observatory, visited Kew in the spring of the year, to study the methods of constructing tabulating scales for the conversion of the indications of his magnetographs into numerical values, in accordance with the recommendations of the International Commission. He also took advantage of the visit to become conversant with the use of the transit instrument, one of which has been recently acquired and set up at the observatory under his charge.

II. Meteorological Observations.

The several self-recording instruments for the continuous registration respectively of Atmospheric Pressure, Temperature, and Humidity, Wind (direction and velocity), Bright Sunshine, and Rain have been maintained in regular operation throughout the year.

The standard eye observations for the control of the automatic records have been duly registered, together with the daily observations in connexion with the U.S. Signal Service synchronous system. A summary of these observations is given in Appendix II.

The tabulations of the meteorological traces have been regularly made, and these, as well as copies of the eye observations, with notes of weather, cloud, and sunshine have been transmitted to the Meteorological Office.

The readings of the old 100-inch area square rain gauge have been discontinued since February, the new 8-inch circular gauge being now regularly employed, as a check upon the indications of the Beckley self-recording instrument.

The working standard barometer (Newman, 34) of the Observatory, which has been in use continuously since the date of its erection in 1851, having become somewhat worn in its mechanism, was dismounted, and the scale and fittings repaired by Negretti and Zambra, without interfering with the tube and cistern, which were retained at the Observatory. On its return it was again put together and restored to its old place, and fresh comparisons made with the Welsh absolute standards. These showed that a slight shift had taken place in the position of the zero of the scale, a new determination of the scale error was made and fresh corrections accordingly adopted. During the period it was under repair the Royal

Society's old standard barometer was used in the daily observations.

The barograph and thermograph formerly at work at the Armagh Observatory have been put in thorough repair, and set up in the Verification House awaiting the instructions of the Meteorological Council as to their transmission to the new Observatory now erected at Fort William, Inverness, at the base of Ben Nevis. It is the intention of the Committee controlling the Observatory on the summit of that mountain, to maintain a second establishment near the sea-level for the purpose of working in conjunction with it. A Beckley rain gauge has been also provided to complete the equipment.

With the sanction of the Meteorological Council, weekly abstracts of the meteorological results have been regularly forwarded to, and published by 'The Times' and 'The Torquay Directory.' Data have also been supplied to the Council of the Royal Meteorological Society, the editor of 'Symons's Monthly Meteorological Magazine,' Dr. Rowland, and others. The cost of these abstracts is borne by the recipients.

Tables of the monthly values of the rainfall and temperature have been regularly sent to the Meteorological Sub-Committee of the Croydon Microscopical and Natural History Club for publication in their Proceedings. Detailed information of all thunderstorms observed in the neighbourhood during the year has been forwarded to the Royal Meteorological Society soon after their occurrence.

Electrograph.—This instrument has been in constant action throughout the year, and comparisons with the portable electrometer (White, 53) made in March, June, and September show the scale value to have remained unchanged.

III. Solar Observations.

Sketches of Sun-spots have been made on 173 days, and the groups numbered after Schwabe's method, the results being given in Appendix II, Table IV.

Time Signals.—At the suggestion of the Engineer at the General Post Office, a galvanometer has been fitted to the chronograph in order that the Greenwich time signal may be observed on those occasions when it fails to record itself on the chronograph. The 10 A.M. signal has only failed on 16 days throughout the year. On 10 of these days, when it was not received at the usual hour, the later one, at 1 P.M., was duly forwarded by the Post Office. The errors of the Greenwich clock on certain selected dates, when some uncertainty existed as to the correctness of the signal received, have been courteously given after application to the Astronomer Royal.

Transit Observations.—Solar and sidereal transits have been occasionally observed as a check on the signalled times.

Violle's Actinometer.—The Committee have undertaken at the request of the Meteorological Council to make observations with a pair of Violle's actinometers. These consist of two delicate mercurial thermometers encased, the one in a well-blackened hollow metal sphere, the other in the centre of a similar sphere thickly gilded and having a highly polished surface. They have been suitably mounted, and are taken out on sunny days, placed side by side in the open air, and then alternately exposed to the Solar rays, and shielded from its action, the behaviour of the thermometers being noted. Up to the present date, 230 observations have been made with them on seven days.

Solar Physics.—The Committee have handed over to the Solar Physics Committee, with the view of their utilisation, the collection of Solar Negatives from 1858 to 1872 taken at Cranford and at Kew, as well as a large number of undistributed copies of the papers on Solar Physics by Messrs. de la Rue, Stewart, and Loewy.

IV. Experimental Work.

Photo-nephograph.—As it was found that a much more suitable site was offered by the roof of the new building for the working of the cloud cameras, the pedestal was removed from the position it formerly occupied and set up on gratings placed on the new roof, the necessary alterations being effected in the electrical attachments. Opportunity was taken at the same time of replacing, by new wire, about 30 yards of the cable which had become damaged during the building operations. As, however, the question of the most convenient way of utilising the cloud pictures is still under consideration by the Meteorological Council, no photographs have been taken during the past year.

Pendulum Observations.—In November last, the series of pendulum observations at the Observatory, as arranged by General Walker, were successfully carried out, and the apparatus then dismounted and conveyed to the Royal Observatory, Greenwich, where it was set up in the Record Room. Mr. Hollis was instructed by Mr. Constable, the Kew Observer, in the routine of observing in the manner employed at Kew, but the operations had to be postponed for several months owing to a pressure of other work at the Greenwich Observatory. The pendulum swings were commenced in June and are now completed, and the results, at both Kew and Greenwich, are being prepared for publication.

Anemometer Constants.—With a view of examining into the accuracy of the graduation of the small anemometers or air-meters that are very much employed in measuring draughts and air-currents in mine-shafts, galleries, and similar places, a whirling apparatus was roughly constructed with materials at hand and set up in the Optical Room.

By means of this a number of experiments were made, which afforded satisfactory results, with several Lowne's air-meters kindly lent by Mr. Casella, the maker. A more complete whirler has now been constructed, and it is intended to include the examination of these air-meters in the list of operations carried on by the Verification Department.

The electrical anemograph mentioned in the 1886 Report as having been sent to Valencia for erection on that island, was returned to Kew in a somewhat damaged condition after a lengthened trial in a very exposed situation. Certain defects in its construction which became evident during its stay there have now been corrected, and, after undergoing thorough repair, the instrument has been erected on a suitable staging on the roof of the Observatory, with the intention of submitting it to a rigorous comparison with the Beckley anemograph working at the same level about 14 feet due south of it.

V. Verification of Instruments.

The following magnetic instruments have been purchased on commission and their constants determined:—

An inclinometer and unifilar magnetometer for U.S. Navy Department, Washington.

An inclinometer for the University of Modena, Italy.

Three magnets for Mauritius.

The total number of other instruments compared in the past year was as follows:—

Air-meters	3
Anemometers	3
Aneroids	77
Artificial horizons	94
Barometers, Marine	72
,, Standard	63
,, Station	20
Compasses	4
Hydrometers	288
Inclinometers	4
Navy Telescopes	99
,, Binoculars	341
Rain Gauges	15
Sextants	292
,, Shades	42
Sunshine Recorders	2
Carried forward	1419

Brought forward	1419
Surveyor's Scales	33
Theodolites	5
Thermometers, Arctic	43
„ Avitreous or Immisch's	457
„ Chemical	81
„ Clinical	10116
„ Deep sea	100
„ Meteorological	1910
„ Mountain	28
„ Solar radiation	6
„ Standards	64
Unifilars	4
Total	14266

Duplicate copies of corrections have been supplied in 26 cases.

The number of instruments rejected on account of excessive error, or which from other causes did not record with sufficient accuracy, was as follows:—

Thermometers, clinical	38
„ ordinary meteorological	16
Various	50

13 Standard Thermometers have also been calibrated, and 6 supplied to different individuals during the year.

There are at present in the Observatory undergoing verification, 10 Barometers, 850 Thermometers, 50 Hydrometers, and 8 Sextants.

The increase in the number of sextants verified during the past year has been considerable, 292 instruments of that kind having been tested, whereas the greatest number in any previous year has been 157. A much larger number of artificial horizons has also passed through the Department, being in nearly all cases flat glass plates set in levelling frames and supplied with spirit levels. These have been all Hall-marked after examination as to trueness of the surface. In accordance with the arrangement mentioned in last year's Report, 440 Navy telescopes and binoculars have been examined and marked for the Admiralty. Also 33 standard measures of length have been tested for the War Office.

The Committee, having considered the advisability of Hall-marking other instruments besides the thermometers submitted to them for verification, instructed Messrs. R. and J. Beck to construct for them an engraving pantagraph, which has been fitted on the Holtzapffel lathe belonging to the Observatory. By its aid the Navy telescopes, binoculars, and Standard Rules have been successfully engraved with mark and number.

VI. Rating of Watches.

During the year 528 entries of watches for rating were made. They were sent for testing in the following classes:—

For class A, 483; class B, 28; and class C, 17.

Of these 119 failed to gain any award; 15 passed with C, 28 with B, 366 with A certificates, and 21 of the latter obtained the highest, class A *especially good.*

In Appendix III will be found statements giving the results of trial of the 26 watches which obtained the highest numbers of marks during the year, the highest position being attained for the third time by Mr. E. F. Ashley. His watch was a keyless single roller fuzee, which obtained 89·1 marks out of a possible 100. He is very closely followed by Mr. A. E. Fridlander, of Coventry, whose keyless double roller fuzee stands only one-tenth of a mark lower on the list, having gained 89·0 marks.

It is satisfactory to note the general improvement in the performance of the watches sent to the Observatory, the proportion of failures of those submitted for trial being but 22 per cent. against 34 per cent. last year. The effect is, moreover, seen in a diminution of the number of entries, for makers are more critical as to the performance of their watches during the timing and springing operations than they were before Kew trials were instituted.

No difficulty has been experienced in maintaining the three safes—in which the watches are placed during rating—at the three temperatures of 40°, 65°, and 90° Faht. respectively, all the year round.

Special attention continues to be given, as before, to the examination of *pocket chronographs*, in accordance with the request of the Cyclists' Union, and the extra tests alluded to in last Report have been regularly enforced.

Marine Chronometers.—Certificates of mean daily rate and of variations of rate at three different temperatures have been awarded to 10 marine chronometers after undergoing the 35 days' trial as specified in the regulations.

VII. Miscellaneous.

Assistance to Observatories, &c.—There have been purchased on commission the following instruments:—Sunshine recorders on Jordan's pattern for the St. Petersburg and Coimbra Observatories; a low range aneroid for Dr. Löwenherz, of Charlottenburg; various pieces of apparatus for the Hong Kong and Mauritius Observatories; and an Ammeter and Voltmeter for Dr. H. Wild, of St. Petersburg.

In accordance with a resolution of the International Meteorological Committee at their Zurich Meeting, a thermometer of very low

range has been constructed to be used as a standard spirit thermometer for comparison with the hydrogen thermometer of the International Office of Weights and Measures at temperatures ranging from zero to about −70° C.

Prepared photographic paper has been procured and supplied to the Observatories at Aberdeen, Batavia, Colába, Falmouth, Lisbon, Mauritius, St. Petersburg, and Stonyhurst, as well as to the Meteorological Office.

Anemograph sheets have been sent to Mauritius, and blank forms for entry of observations, &c., distributed to various applicants.

Old Mural Quadrant.—The Department of Science and Art having accepted the old mural quadrant for exhibition in the science collection at South Kensington, application was made to the Governors of the Armagh Observatory for the telescope and object glass belonging to the instrument, which had been found by Dr. Dreyer in the Armagh collection of astronomical apparatus, forwarded to that Observatory at the time of the abolition of the King's Observatory at Kew in 1840. The Committee's request having been acceded to, the missing parts were duly received at Kew and forwarded to the Museum Galleries at South Kensington.

Exhibition.—The Committee contributed to the annual exhibition of the Royal Meteorological Society, held in March (19–22), several actinometers, solar radiation thermometers, and photometers.

Library.—During the year the library has received as presents the publications of—

29 Scientific Societies and Institutions of Great Britain and Ireland, and

81 Foreign and Colonial Scientific Establishments, as well as numerous private individuals;

The Librarian has been engaged for some time in the preparation of a card catalogue of the library, on the model of that of the Meteorological Office, and has now completed over 1,100 cards, which contain the titles, &c., of all works received by the Committee during the past seven years, together with those of a like title which had been received previously.

The publications not yet catalogued formed part of Sir E. Sabine's Magnetic Office collection, and are chiefly excerpts from foreign publications and reports. They have generally but little interest, and are being examined with the view of binding such as the Observatory does not possess in other forms, and disposing of the duplicates.

Workshop.—The machine tools procured for the use of the Kew Observatory by grants from the Government Grant Fund or the Donation Fund have been duly kept in order.

House, &c.—The external walls of the Observatory, as well as the out-houses, have been thoroughly painted. Book shelves and presses have been fitted to the new rooms, which have also been furnished. Glazed sashes have been inserted in the West Wing Thermometer Room, in place of the panels which formerly filled the window frame, and new pipes have been fixed for the water supply of the House.

PERSONAL ESTABLISHMENT.

The staff employed is as follows:—

G. M. Whipple, B.Sc., Superintendent.
T. W. Baker, Chief Assistant.
H. McLaughlin, Librarian.
E. G. Constable, Observations and Rating.
W. Hugo, Verification Department.
J. Foster ,, ,,
T. Gunter.
W. J. Boxall, and seven other Assistants.

(Signed) FRANCIS GALTON,
Chairman of the Kew Committee.

November 29th, 1889.

The Kew Observatory. Account of Receipts and Payments for the year ending October 31st, 1889.

Dr. **RECEIPTS.**

	£	s.	d.
To Balance from 1887–88	£388	6	10
Royal Society (Gassiot Trust)	487	10	0
Meteorological Office (Allowance)	400	0	0
Experimental Work	99	10	10
Miscellaneous	79	8	4
Verifications	241	6	6
Rating of Watches and Chronometers	485	17	4
	3211	19	10
Meteorological Office for Postages and Porterages	5	13	9
Commissions executed for Colonial and Foreign Institutions, &c.	328	17	6
	£3546	11	1

PAYMENTS. *Cr.*

	£	s.	d.
By Salaries and Extra	£1745	8	0
Gas, Fuel, Rent, Insurance, &c.	186	1	3
Stationery, Postages, Porterages, &c.	64	2	9
Instruments, Apparatus, &c.	97	15	10
Experimental work	22	2	11
Miscellaneous	37	10	8
Verifications	178	11	7
Rating of Watches and Chronometers	121	18	11
Pendulum	88	14	10
	2542	6	9
Extension of the Building and Fittings	88	3	5
Postages and Porterages, &c., for Meteorological Office	5	13	3
Commissions executed for Colonial and Foreign Institutions, &c.	348	1	9
Balance—Bank of England	452	4	2
London and County Bank	99	18	11
Cash in hand	10	2	10
	562	5	11
	£3546	11	1

November 11, 1889. Examined and compared with the Vouchers, and found correct, (Signed) G. CAREY FOSTER, *Auditor.*

ASSETS.

	£	s.	d.
Balance as per Statement	562	5	11
Meteorological Office Allowance, Experimental, and Sundries	36	0	0
Verification Fees due, &c.	129	4	6
Rating of Watches, &c.	48	10	10
Photographic Paper	5	1	3
Commissions, &c.	87	13	11
Blank Forms	28	7	0
Standard Thermometers in Stock	88	0	6
	£985	3	11

LIABILITIES.

	£	s.	d.
To Gas and Sundries	7	12	0
Pendulum Account—Unspent Balance	121	18	0
Purchases on Commission	42	7	11
Balance	813	6	0
	£985	3	11

November 18, 1889.

(Signed) G. M. WHIPPLE,
Superintendent.

APPENDIX I.

Magnetic Observations made at the Kew Observatory, Lat. 51° 28′ 6″ *N. Long.* 0^{h} 1^{m} 15^{s}·1 *W., for the year October* 1888 *to September* 1889.

The observations of Deflection and Vibration given in the annexed Tables were all made with the Collimator Magnet marked K C 1, and the Kew 9-inch Unifilar Magnetometer by Jones.

The Declination observations have also been made with the same Magnetometer, Collimator Magnet N E being employed for the purpose.

The Dip observations were made with Dip-circle Barrow No. 33, the needles 1 and 2 only being used; these are $3\frac{1}{2}$ inches in length.

The results of the observations of Deflection and Vibration give the values of the Horizontal Force, which, being combined with the Dip observations, furnish the Vertical and Total Forces.

These are expressed in both English and metrical scales—the unit in the first being one foot, one second of mean solar time, and one grain; and in the other one millimetre, one second of time, and one milligramme, the factor for reducing the English to metric values being 0·46108.

By request, the corresponding values in C.G.S. measure are also given.

The value of log $\pi^2 K$ employed in the reduction is 1·64365 at temperature 60° F.

The induction-coefficient μ is 0·000194.

The correction of the magnetic power for temperature t_0 to an adopted standard temperature of 35° F. is

$$0{\cdot}0001194(t_0-35)+0{\cdot}000{,}000{,}213(t_0-35)^2.$$

The true distances between the centres of the deflecting and deflected magnets, when the former is placed at the divisions of the deflection-bar marked 1·0 foot and 1·3 feet, are 1·000075 feet and 1·300097 feet respectively.

The times of vibration given in the Table are each derived from the mean of 14 observations of the time occupied by the magnet in making 100 vibrations, corrections being applied for the torsion-force of the suspension-thread subsequently.

No corrections have been made for rate of chronometer or arc of vibration, these being always very small.

The value of the constant P, employed in the formula of reduction $\frac{m}{X}=\frac{m'}{X'}\left(1-\frac{P}{r_0^2}\right)$, is −0·00205.

In each observation of absolute Declination the instrumental readings have been referred to marks made upon the stone obelisk erected 1250 feet north of the Observatory as a meridian mark, the orientation of which, with respect to the Magnetometer, has been carefully determined.

The observations have been made and reduced by Mr. T. W. Baker.

Table I.

Observations of Inclination or Dip.

Month.	Mean Inclination.	Month.	Mean Inclination.
1888.		1888.	
October 30.....	67° 34′·9	April 26.....	67° 35′·1
31.....	67 34·4	27.....	67 33·0
Mean.....	67 34·6	Mean.....	67 34·0
November 27.....	67 34·0	May 28.....	67 34·7
28.....	67 34·3	30.....	67 32·1
Mean.....	67 34·2	31.....	67 34·1
		Mean.....	67 33·6
December 24.....	67 34·2		
27.....	67 34·0	June 24.....	67 34·1
Mean.....	67 34·1	25.....	67 33·8
		Mean.....	67 33·9
1889.			
January 28.....	67 34·2	July 29.....	67 33·6
29.....	67 34·4	30.....	67 33·5
Mean.....	67 34·3	Mean.....	67 33·6
February 25.....	67 34·2	August 26.....	67 34·2
27.....	67 34·7	27.....	67 34·9
Mean.....	67 34·4	Mean.....	67 34·6
March 26.....	67 34·0	October 3.....	67 34·7
28.....	67 34·6		
Mean.....	67 34·3		

Table II.

Observations of the Absolute Measure of Horizo ntal Force.

Month.	Log $\frac{m}{X}$ mean.	Log mX mean.	Value of m.*
1888.			
November 1st	9·11991	0·30822	0·51768
November 29th	9·11952	0·30828	0·51749
December 28th.....	9·11977	0·30826	0·51763
1889.			
January 30th.....	9·11946	0·30842	0·51754
February 28th	9·11944	0·30839	0·51751
March 29th	9·11925	0·30844	0·51742
April 29th and 30th	9·11919	0·30843	0·51738
May 25th and 27th.....	9·11876	0·30860	0·51723
June 26th and 27th.....	9·11873	0·30857	0·51721
July 31st	9·11846	0·30845	0·51696
August 29th.....	9·11852	0·30847	0·51701
October 1st and 2nd	9·11830	0·30833	0·51679

Table III.—Solar Diurnal Range of the Kew Declination as derived from selected quiescent days.

Hour.	Summer mean.	Winter mean.	Annual mean.
1889.			
Midnight	−0′·7	−0′·8	−0′·7
1	−0·9	−0·4	−0·6
2	−1·1	−0·4	−0·7
3	−1·2	−0·2	−0·7
4	−1·6	−0·4	−1·0
5	−2·3	−0·5	−1·4
6	−2·9	−0·6	−1·8
7	−3·5	−0·7	−2·1
8	−3·5	−1·0	−2·2
9	−2·7	−1·0	−1·9
10	−0·7	−0·2	−0·5
11	+1·8	+1·2	+1·5
Noon	+4·0	+2·5	+3·2
13	+5·3	+2·9	+4·1
14	+4·7	+2·1	+3·4
15	+3·2	+1·2	+2·2
16	+1·6	+0·5	+1·1
17	+0·6	+0·1	+0·3
18	0·0	−0·1	0·0
19	−0·1	−0·3	−0·2
20	−0·3	−0·6	−0·5
21	−0·3	−0·9	−0·6
22	−0·2	−0·9	−0·6
23	−0·4	−0·9	−0·7

When the sign is + the magnet points to the west of its mean position.

* m = magnetic moment of vibrating magnet.

Table IV.

Month.	Declination.		Magnetic Intensity.								
			English Units.			Metric Units.			C. G. S. Measure.		
	Mean of Observations.	Mean corrected for Diurnal Range.	X, or Horizontal Force.	Y, or Vertical Force.	Total Force.	X, or Horizontal Force.	Y, or Vertical Force.	Total Force.	X, or Horizontal Force.	Y, or Vertical Force.	Total Force.
	West.	West.									
1888.											
October ..	18 3·7	17 58·1	3·9279	9·5188	10·2975	1·8111	4·3889	4·7480	0·1811	0·4389	0·4748
November .	18 3·1	17 57·7	3·9299	9·5205	10·2996	1·8120	4·3898	4·7490	0·1812	0·4390	0·4749
December .	18 1·2	17 55·8	3·9286	9·5166	10·2956	1·8114	4·3879	4·7471	0·1811	0·4388	0·4747
1889.											
January ..	18 1·3	17 55·8	3·9308	9·5234	10·3027	1·8124	4·3911	4·7504	0·1812	0·4391	0·4750
February..	18 2·7	17 57·3	3·9308	9·5242	10·3034	1·8124	4·3915	4·7507	0·1812	0·4392	0·4751
March	18 2·3	17 56·8	3·9319	9·5260	10·3055	1·8129	4·3923	4·7517	0·1813	0·4392	0·4752
April	18 6·5	18 1·0	3·9321	9·5242	10·3039	1·8130	4·3915	4·7509	0·1813	0·4392	0·4751
May.. ...	18 7·0	18 1·3	3·9348	9·5275	10·3081	1·8143	4·3930	4·7529	0·1814	0·4393	0·4753
June	18 4·4	17 58·8	3·9348	9·5300	10·3103	1 8143	4·3941	4·7539	0·1814	0·4394	0·4754
July.....	18 7·8	18 2·1	3·9355	9·5293	10·3100	1 8146	4·3938	4·7538	0·1815	0·4394	0·4754
August ..	18 5·8	18 0·4	3·9353	9·5367	10·3169	1·8145	4·3972	4·7570	0·1815	0·4397	0·4757
September.	18 1·5	17 55·5	3·9356	9·5383	10·3183	1·8146	4·3979	4·7576	0·1815	0·4398	0·4758

APPENDIX II.

Meteorological Observations.—Table I.

Mean Monthly results.

Months.	Thermometer.								Barometer.*					Mean vapour-tension.
	Mean.	Means of—			Absolute Extremes.				Mean.	Absolute Extremes.				
		Max.	Min.	Max. and Min.	Max.	Date.	Min.	Date.		Max.	Date.	Min.	Date.	
1888.	°	°	°	°	°	d. h.	°	d. h.	ins.	ins.	d. h.	ins.	d. h.	in.
Oct.....	45·0	53·6	37·5	45·6	66·9	27 2 P.M.	28·1	3 6 A.M.	30·079	30·471	22 10 A.M.	29·290	2 3 P.M.	·251
Nov. ...	47·3	51·2	43·3	47·3	58·7	16 Noon	34·9	28 9 „	29·809	30·267	23 6 P.M.	29·219	30 4 A.M.	·280
Dec. ...	40·6	44·9	35·6	40·3	57·3	5 1 P.M.	26·1	31 {11 P.M. &Midt.}	30·000	30·523	16 10 A.M.	28·990	22 1 „	·230
1889.														
Jan.....	37·0	41·0	32·0	36·5	53·0	31 1 P.M.	19·7	6 9 A.M.	30·193	30·751	3 10 „	29·272	10 1 „	·195
Feb. ...	37·4	42·5	32·3	37·4	55·8	1 2 „	14·9	13 6 „	29·923	30·476	18 {11 „ &Noon}	29·149	3 8 P.M.	·182
March..	40·6	47·3	34·2	40·8	58·3	24 3 „	20·9	4 7 „	30·000	30·626	15 9 P.M.	28·989	20 4 „	·199
April...	45·8	52·6	39·8	46·2	61·9	{18 5 „ 19 3 „}	33·6	16 5 „	29·751	30·257	19 8 A.M.	29·192	4 3 „	·248
May ...	56·0	64·0	48·9	56·5	77·9	24 2 „	41·9	1 Midt.	29·841	30·123	20 9 P.M.	29·490	25 3 A.M.	·360
June...	60·8	69·5	52·6	61·1	79·2	6 3 „	45·8	1 3 A.M.	30·040	30·428	5 8 A.M.	29·634	10 3 „	·402
July ...	60·6	68·4	53·5	61·0	76·7	6 4 „	47·0	{19 4 „ 24 5 „}	29·945	30·425	1 11 P.M.	29·553	25 7 P.M.	·402
Aug....	59·4	67·8	52·1	60·0	80·2	1 1 „	45·1	25 5 „	29·896	30·275	27 10 „	29·209	20 6 A.M.	·399
Sept....	55·5	63·5	48·1	55·8	76·3	11 4 „	34·7	17 6 „	30·056	30·456	16 9 A.M.	29·513	24 2 P.M.	·350
Means..	48·8	55·5	42·5	49·0	..	....	..	....	29·961	..	....	..	....	·292

The above Table is extracted from the "Hourly Readings," vols. 1888-89, of the Meteorological Office, by permission of the Meteorological Council.

* Reduced to 32° at M.S.L.

Meteorological Observations.—Table II.

Kew Observatory.

Months.	Mean amount of cloud (0=clear, 10=overcast).	Rainfall.*			Weather. Number of days on which were registered								Wind.† Number of days on which it was								
		Total.	Maximum.	Date.	Rain.	Snow.	Hail.	Thunderstorms.	Clear sky.	Overcast sky.	Gales.	Calms.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Variable.
1888.		in.	in.																		
October ..	5	1·325	0·565	29	8	..	1	..	10	8	..	12	5	2	5	1	2	5	6	4	1
November	8	3·895	0·680	2	19	..	..	..	1	18	1	2	1	2	8	2	3	9	4	..	1
December	7	1·390	0·340	10	10	..	..	..	8	16	..	9	5	1	2	3	8	4	3	3	2
1889.																					
January..	8	0·910	0·280	9	13	1	..	..	2	20	..	11	10	4	1	1	2	5	5	2	1
February .	8	2·070	0·495	10	16	12	1	..	2	17	..	..	5	5	..	1	1	3	7	4	2
March ...	7	1·360	0·300	7	12	3	..	..	..	16	1	2	4	3	3	2	3	3	8	3	2
April	7	2·235	0·435	9	25	..	2	2	1	16	1	2	6	3	4	2	5	5	2	2	1
May.....	7	3·045	1·510	26	15	..	2	2	4	12	..	5	3	5	6	1	7	5	3	1	..
June	6	1·280	0·435	15	5	..	1	2	3	10	..	6	5	10	5	1	1	3	2	2	1
July.....	7	3·050	0·640	12	17	..	2	4	2	12	..	7	2	2	2	2	5	8	5	4	1
August ..	6	2·170	0·335	21	17	..	1	3	5	11	..	3	..	..	1	..	4	15	8	3	..
September	6	1·570	0·795	24	9	..	..	1	6	10	..	6	4	4	3	2	2	6	5	3	1
Totals..		24·300			166	16	9	14	44	166	3	65	50	41	40	18	43	71	58	31	13

* Measured at 10 A.M. daily by gauge 1·75 feet above surface of ground. † As registered by the anemograph.

Meteorological Observations.—Table III.

Kew Observatory.

Months.	Bright Sunshine.				Maximum temperature in sun's rays. (Black bulb *in vacuo*.)			Minimum temperature on the ground.			Horizontal movement of the Air.*		
	Total number of hours recorded.	Mean percentage of possible sunshine.	Greatest daily record.	Date.	Mean.	Highest.	Date.	Mean.	Lowest.	Date.	Average hourly Velocity.	Greatest hourly Velocity.	Date.
1888.	h. m.		h. m.		deg.	deg.		deg.	deg.		miles.	miles.	
October	112 6	33	9 36	1	94	111	27	31	21·0	8	7	27	27
November	26 6	10	6 12	20	70	93	14	39	26·6	28	15	35	7
December	34 48	14	6 0	7	65	96	5	31	18·1	14	9	34	27
1889.													
January	24 0	9	5 36	19	58	87	18	28	19·0	2	8	30	29
February	52 30	19	7 30	15	76	98	18	28	8·8	13	13	33	4, 9
March	83 42	23	8 42	9	92	111	30	28	13·5	4	11	36	21
April	91 42	22	13 12	29	101	120	22, 29	34	22·3	16	11	35	21
May	148 0	31	13 24	24	113	135	24	45	32·4	2	9	32	9
June	199 54	40	13 48	1	121	138	4, 27	49†	40·6	1	8	29	10
July	146 54	30	12 48	6	126	139	13	50	42·3	19	9	29	10
August	169 6	38	12 0	7	123	138	1	48	37·2	25	9	28	20
September	132 36	35	10 24	17	111	131	12	42	26·6	23	8	24	2

* As indicated by a Robinson's anemograph, 70 feet above the general surface of the ground.
† Instrument dismounted for one day.

Table IV.

Summary of Sun-spot Observations made at the Kew Observatory.

Months.	Days of observation.	Number of new groups enumerated.	Days apparently without spots.
1888.			
October	21	1	19
November	7	2	1
December	7	1	3
1889.			
January	10	0	10
February	8	2	3
March	18	1	11
April	14	1	11
May	19	1	17
June	21	1	10
July	19	5	8
August	14	3	3
September	15	1	10
Totals	173	19	106

APPENDIX III.—Table I.

RESULTS OF WATCH TRIALS. Performance of the 26 Watches which obtained the highest number of marks during the year.

Watch deposited by	Number of watch.	Balance spring, escapement, &c.	Mean daily rate. —+Gaining. —Losing.	Mean variation of daily rate. ±	Mean change of rate for 1° F	Difference of mean daily rate				Difference between extreme gaining and losing rates.	Marks awarded for			Total Marks. 0—100.
						Between pendant up and dial up.	Between pendant up and pendant right.	Between pendant up and pendant left.	Between dial up and dial down.		Daily variation of rate.	Change of rate with change of position.	Temperature compensation.	
			secs.	secs	secs.	secs.	secs.	secs.	secs.	secs.				
E. F. Ashley, London	03801	Single overcoil, *s.r., fusee	+1·4	0·35	0·04	−0·1	−0·2	−0·6	−0·6	4·25	33·0	38·9	17·2	89·1†
A. E. Fridlander, Coventry	52292	Single overcoil, *d.r., fusee	+4·9	0·4	0·01	−0·8	−0·1	−1·1	−0·9	4·0	32·1	37·7	19·2	89·0†
E. F. Ashley, London	03770	Single overcoil, s.r., *g.b.	−0·9	0·4	0·06	+1·0	+0·3	0·0	−0·1	3·75	32·2	38·3	16·1	86·6†
W. Holland, Rock Ferry	3612	Single overcoil, d.r., fusee, centre-seconds	+0·9	0·4	0·05	0·0	+0·1	+0·5	+1·5	5·0	31·6	38·2	16·5	86·3†
Stauffer, Son, & Co., London	126681	Single overcoil, d.r., g.b., bar-lever	−7·8	0·4	0·05	+0·8	−2·2	+0·9	−1·5	6·25	31·8	36·1	16·8	84·7†
Joseph White, Coventry	32133	Single overcoil, d.r., g.b.	−4·7	0·4	0·04	−0·7	−1·8	+1·2	+2·8	5·25	32·2	35·2	17·1	84·5†
Baume & Co., London	2836	Single overcoil, d.r., g.b., bar-lever	+1·0	0·5	0 04	+1·2	+0·8	−0·8	−2·4	4·5	30·6	36·5	17·3	84·4†
Usher & Cole, London	25430	Single overcoil, s.r., g.b.	+0·3	0·5	0·06	−0·9	−0·3	−0·7	+2·1	6·75	30·2	37·6	16·3	84·1†
Rotherham & Sons, Coventry	84377	Single overcoil, s.r., g.b	+2·9	0·4	0·05	+4·6	+0·8	+1·0	−3·2	7·0	31·8	35·1	16·9	83·8
J. J. Stockall, London	10416	Single overcoil (palladium), s.r., g.b.	−1·9	0·4	0·03	−2·7	+3·1	+0·5	+1·8	8·0	31·7	34·2	17·9	83·8
Rotherham & Sons, Coventry	84278	Single overcoil (palladium), s.r., g.b.	+2·3	0·5	0·03	0·0	−0·9	−1·6	+3·2	6·25	30·6	35·1	18·0	83·7†
Stauffer, Son, & Co., London	124228	Single overcoil, d.r., g.b.	+2·8	0·4	0·04	−2·0	+1·3	+3·0	+1·7	8·0	32·0	34·4	17·2	83·6†
Joseph White, Coventry	31614	Single overcoil, d.r., g.b., centre-seconds	+0·1	0·5	0·04	+1·4	0·0	+2·5	−0·5	4·75	29·3	36·8	17·4	83·5†
H. Golay, London	2808	Double overcoil, d.r., g.b.	+2·8	0·5	0·03	−2·3	+1·2	−2·3	+0·3	7·25	30·6	34·6	17·9	83·1†
Baume & Co., London	2786	Single overcoil, d.r., g.b., bar-lever	+1·3	0·4	0·05	+1·2	−1·8	−0·6	−4·0	5·25	31·2	35·2	16·5	82·9
W. Holland, Rock Ferry	3641	Single overcoil, d.r., g b., centre-seconds	+0·3	0·4	0·07	+0·6	−2·9	−1·9	−2·5	5·5	31·6	35·3	15·2	82·1†
W. Holland, Rock Ferry	3247	Single overcoil, d.r., fusee	+0·1	0·6	0·01	−1·0	+1·6	+1·9	−0·1	6·5	27·6	35·3	19·1	82·0
Joseph White, Coventry	31812	Single overcoil, d.r., g.b.	+2·8	0·6	0·06	−0·8	−0·9	−1·3	+1·0	6·0	28·4	37·8	15·8	82·0
A. E. Fridlander, Coventry	52625	Single overcoil, d.r., g.b.	+2·2	0·4	0·07	−0·1	+2·4	+2·8	−0·7	6·25	31·9	34·5	15·1	81·5†
Gaydon & Sons, Kingston-on-Thames	55781	Single overcoil (palladium), d.r., g.b.	+1·9	0·5	0·07	−1·8	−1·4	−3·9	−0·4	7·25	29 9	36·2	15·3	81·4
E. F. Ashley, London	03784	Single overcoil, d.r., fusee	−0·6	0·4	0·10	+1·5	−1·0	−0·6	−0·4	6·25	31·1	36·5	13·5	81·1†
Stauffer, Son, & Co., London	124225	Single overcoil, d.r., g.b.	+4·2	0·6	0·07	+1·0	+1·0	+1·0	−0·5	6·25	27·4	38·6	15·1	81·1
A. E. Fridlander, Coventry	52498	Single overcoil, d.r., g.b.	+2·9	0·5	0·05	−0·6	−2·1	−5·2	−0·5	8·0	30·4	34·0	16·7	81·1
A. E. Fridlander, Coventry	52483	Double overcoil, d.r., g.b.	−1·9	0·4	0·04	−1·9	+3·7	−4·6	+1·3	0·0	32·0	31·9	17·1	81·0†
Baume & Co., London	2778	Single overcoil, d r., g.b., bar-lever	−1·7	0·5	0·07	+0·3	−0·6	+1·4	−3·1	16·25	29·8	35·6	15·6	81·0
L. Rozat, Chaux-de-Fonds	42102	Single overcoil, s.r., g.b.	+6·1	0·7	0·04	−0·1	+1·0	−0·1	+0·9	5·75	25·8	38·1	17·1	81·0

* d.r., double-roller; s.r., single-roller; g.b., going barrel.

† Especially good.

APPENDIX III.—Table II.

Highest Records obtained by Complicated Watches during the year.

Description of watch.	Number.	Deposited by	Marks awarded for			Total marks, 0—100.
			Variation.	Position.	Temperature.	
Minute and seconds chronograph and repeater ..	52625	A. E. Fridlander, Coventry ...	31·9	34·5	15·1	81·5*
,, ,, ,, ,, ..	14781	S. Smith and Son, London ...	27·0	28·6	9·1	64·7
Split-seconds and minute-recorder chronograph.	2836	Baume and Co., London.....	30·6	36·5	17·3	84·4*
,, ,, ,, ,, .	2813	H. Golay, ,, ...	26·7	33·8	15·5	76·0
,, ,, ,, ,, .	125935	Stauffer and Co., ,, ...	25·2	35·0	14·2	74·4
Minute and seconds chronograph.....	52483	A. E. Fridlander, Coventry ...	32·0	31·9	17·1	81·0*
,, ,, ,, ...	124440	Stauffer and Co., London.....	30·2	32·8	17·9	80·9
,, ,, ,, ...	3678	H. Golay, ,, ...	27·5	35·7	17·0	80·2
Repeater	1703	W. Vasel, London	30·7	35·3	10·2	76·2*
,, ...	30388	M. F. Dent, ,, ...	26·7	31·2	15·8	73·7
,, ...	3677	H. Golay, ,, ...	28·7	29·1	13·4	71·2
Ordinary seconds chronograph	30822	S. Smith and Son, London	25·1	28·4	9·7	63·2
,, ,, ,, ...	99771	Newsome and Co., Coventry ..	23·6	28·7	10·4	62·7

* Especially good.

APPENDIX IV.

List of Instruments, Apparatus, &c., the Property of the Kew Committee, at the present date out of the custody of the Superintendent, on Loan.

To whom lent.	Articles.	Date of loan.
G. J. Symons, F.R.S.	Portable Transit Instrument	1869
The Science and Art Department, South Kensington.	The articles specified in the list in the Annual Report for 1876, with the exception of the Photo-Heliograph, Pendulum Apparatus, Dip-Circle, Unifilar, and Hodgkinson's Actinometer.	1876
Lieutenant A. Gordon, R.N.	Unifilar Magnetometer by Jones, No. 102, complete, with three Magnets and Deflection Bar. Dip-Circle, by Barrow, one Pair of Needles, and Magnetizing Bars. One Bifilar Magnetometer. One Declinometer. Two Tripod Stands.	1883
Professor W. Grylls Adams, F.R.S.	Unifilar Magnetometer, by Jones, No. 101, complete. Pair 9-inch Dip-Needles with Bar Magnets ...	1883 1887
Professor O.J. Lodge, F.R.S.	Unifilar Magnetometer, by Jones, No. 106, complete. Barrow Dip-Circle, No. 23, with two Needles, and Magnetizing Bars. Tripod Stand.	1883
Captain W. de W. Abney, F.R.S.	Mason's Hygrometer, by Jones	1885
Prof. T. E. Thorpe, F.R.S.	Tripod Stand	1886
Lord Rayleigh, F.R.S.	Standard Barometer (Adie, No. 655)	1885